



The Tiyeeni Deep-Bed Farming System

A Field Manual



Promoting sustainable farming in Malawi

The Tiyei Deep-Bed Farming System: A Field Manual

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1 What is Tiyeeni?

Founded in 2005, Tiyeni is a charity and non-governmental organisation dedicated to supporting the development of sustainable and resilient livelihoods among farmers in Malawi, through providing training and extension support in its unique deep-bed farming system.

The deep-bed farming system incorporates elements of ‘conservation agriculture’ techniques and offers an alternative to traditional agricultural practices in the region, which in recent years have been characterised by declining crop yields and food insecurity. This has occurred as a result of various socio-economic and environmental factors, including:

- **declining soil fertility** – caused by the lack of affordability of artificial fertilisers, or farmer access to livestock manure;
- **increasing soil erosion** – caused by destructive husbandry practices that facilitate increased surface runoff; a World Bank report in 1992 suggested that Malawi loses 20 tonnes of soil per year per hectare by erosion;
- **climate change and flooding** – farmers are struggling to adapt to increasingly unpredictable weather across central and southern Africa. Malawi suffered major flooding and drought events in 2015 and 2016, which have had a major impact on soil erosion, crop production and food security;
- **population pressure** – Malawi’s population growth rate is currently around 3%; the population doubles every 30 years while the amount of good quality arable land is declining.

Tiyeni builds farmers’ resilience to these pressures and impacts through extension of its deep-bed farming system package, which incorporates a range of non-destructive environmentally, economically and socially sustainable land management practices:

- **contour terracing with closed ridge and furrows** – reduces soil and water loss from cultivation plots, and encourages groundwater recharge;

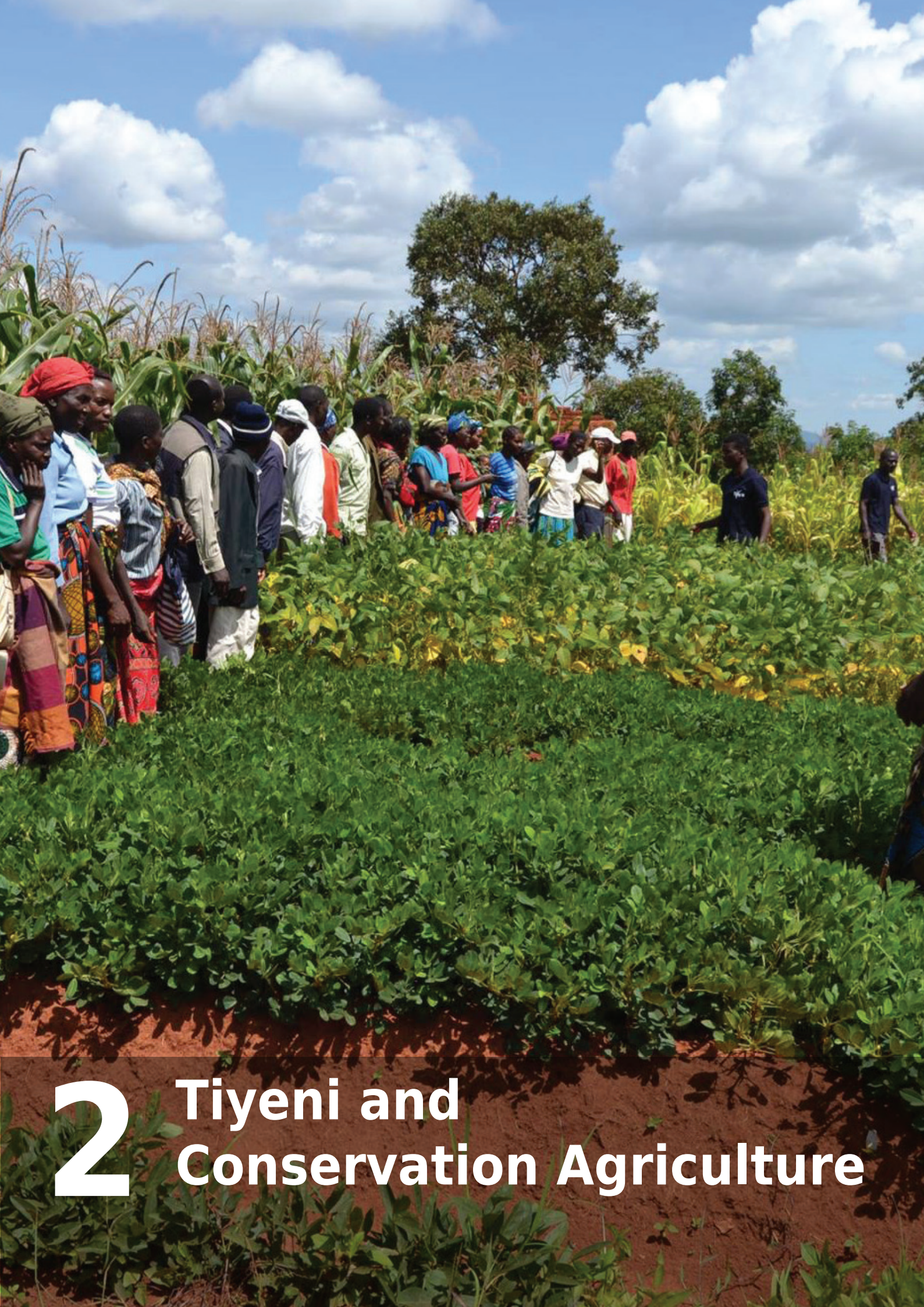
- **breaking the hard pan** prior to cultivation – ensures a deeper rooting depth;
- **deep and wide beds** are constructed – ensures a deeper rooting depth and minimises soil erosion;
- **zero tillage** and **restricted access** to the deep beds – minimises soil compaction and the mineralisation of organic matter;
- **mulching** – reduces evaporation from exposed beds and increases soil fertility matter;
- **composting** – farmers learn how to create good quality compost from animal manure and crop residue, so that these can be added to the beds;
- **intercropping** and agroforestry – maize can be grown alongside different vegetables or leguminous plants;
- off-farm **piggeries** – are sources of animal manure and income.

Tiyeni works by responding to requests for training and extension from community members, who will seek the designation of a ‘**demonstration garden**’ from their community leader. Tiyeni will then train ‘**lead farmers**’ in the deep-bed farming system by helping them implement this in their designated demonstration garden. Lead farmers are subsequently responsible for disseminating the deep-bed farming system further and training ‘**extension farmers**’. After the training, Tiyeni provides follow-up support and advice for a period of three years after which self-sufficiency is achieved.

To date, Tiyeni has established 34 demonstration gardens and trained over 1000 farmers in the deep-bed farming system in the **Mzuzu** area. In those areas where the deep-bed farming system has been adopted, farmers report a significant and sustained increase in crop production (usually more than double the conventional yield of maize) which has had a dramatic impact on food security and livelihood resilience. As the benefits of the deep-bed farming system have become clear, and word of its success has spread throughout the region, there has been a significant increase in demand for Tiyeni’s training.

This field manual has been developed as a resource for farmers and technical staff who have an interest in adopting Tiyei's deep-bed farming system as a means of increasing crop production in a sustainable manner. The aim is to provide the user with a background and context to the Tiyei method, as well as detailed step-by-step guidelines for its field implementation. It should, however, be regarded as a starting point, and the authors strongly encourage users to critically reflect and feedback their experiences of engaging with the material presented here and their implementation of the deep-bed farming system in the field, so that Tiyei can continue to share the experiences of its '**community of practice**'. Indeed, we welcome any comments and suggestions for improving this manual and the training practices themselves.





2 Tiyeni and Conservation Agriculture

In Malawi, the traditional ridge and furrow system practised by the majority of the population is characterised by crops being grown annually on raised seed beds through the continuous hoeing and tillage of the land. This system is widely regarded as being both labour intensive and environmentally destructive, and evidence suggests that it leads to significant problems of soil compaction and erosion, the loss of organic matter, a reduction in water infiltration, and consequently a decline in crop yields over time (especially in the absence of chemical inputs) (Materechera and Mloza-Banda, 1997; Ngwira *et al*, 2013).

In contrast, The Tiyeni deep-bed farming system draws on many of the ideas and concepts behind Conservation Agriculture (CA), an approach originally developed in the Americas but promoted widely across sub-Saharan Africa in recent years, since it represents:

“... an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment.”

(FAO, 2015)

At its core are three key principles:

1) Minimal soil disturbance

Continuous or mechanised tillage of the soil (ridge and furrows) cause mineralisation, compaction and erosion. The loss of organic matter affects the physical structure of the soil and together with the compaction caused by repeated trampling and tillage, reduces significantly the availability of plant nutrients and water availability. The structural change to the soil also reduces root depth and formation, again resulting in degraded conditions for crop production. By reducing the amount of soil tillage and trampling (by humans or livestock), a looser soil structure can

be maintained which promotes water infiltration, organic matter accumulation, and root growth. Seed planting under conditions of minimal tillage usually involve the direct placing of seeds in slots in the bed.

2) Maintaining permanent soil cover

Continuous exposure of the soil to sun and water can similarly increase soil desiccation, compaction, erosion and the loss of organic matter. The use of cover crops or mulching can protect the soil against these impacts, while also promoting a micro-environment that supports the growth and development of beneficial soil organisms. Insects, fungi and bacteria aid the decomposition of crop residues and support humus formation through biological tillage. The outcome is soil that retains its organic matter and water, while sustaining biodiversity.

3) Crop rotation and diversification

Crop rotation is widely regarded as having a positive impact on agriculture. Different crops have different growing requirements in terms of root depths, nutrient demands, and the biological activities associated with these. Crop rotation helps ensure a constant recycling of nutrients (often enhanced by the use of leguminous plants), a diversity in soil structure, and it reduces the risk of problems associated with persistent weeds, pests or diseases. Furthermore, crop rotation and diversification reduces the risk of total crop failure, and hence has a key role to play in enhancing livelihood resilience.

There is increasing evidence from around the world that CA approaches can, in many circumstances, lead to enhanced livelihood security and environmental sustainability, and as of 2015 an estimated 157 million hectares of farmland globally had adopted CA methods (FAO, 2015). Malawi is currently estimated to have around 65,000 hectares of CA, the majority of which has been promoted through the actions of NGOs and the Ministry of Agriculture and Food Security (particularly through the Farm Income

Diversification Programme). Recent studies on CA in Malawi (see Concern Universal, 2011; Ngirwa *et al*, 2013; Andersson and D'Souza, 2014) have highlighted the way in which the adoption and spread of new CA methods across the country have been influenced by the country's unique social, economic, political and environmental context. One size does not fit all, and what constitutes CA practice in different parts of Malawi, can differ considerably to what are considered CA methods even in neighbouring Zambia, Zimbabwe, Tanzania and Mozambique. Typically, where CA farming is being practised in Malawi, there is a focus on the use of herbicides, minimum tillage, agro-forestry and inter-cropping (rather than crop rotation) (Andersson and D'Souza, 2014).

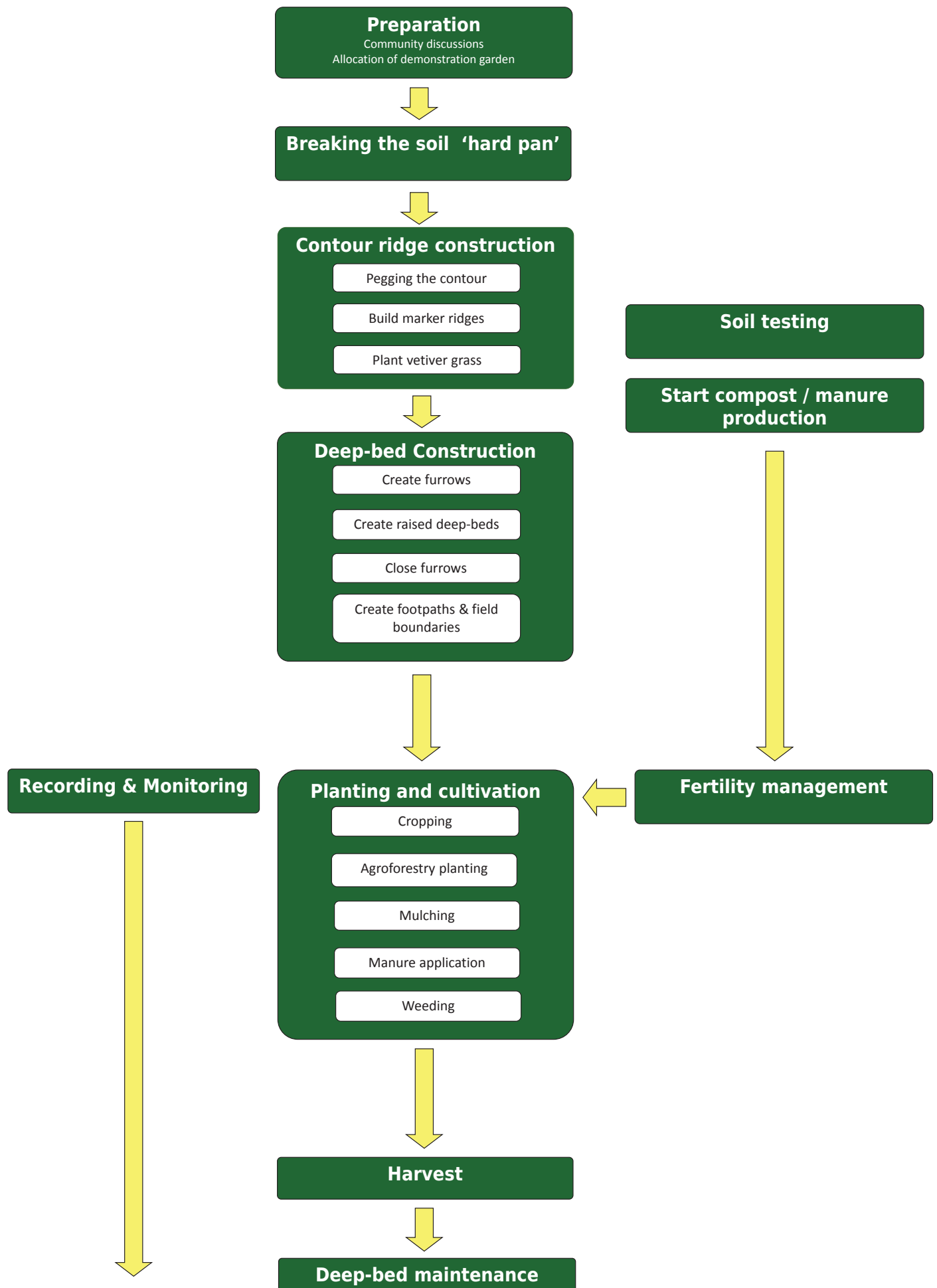
It is within this context that ***Tiyeni's deep-bed method has emerged as a good example of a regional adaptation of the principles and practices of CA.*** Tiyeni's method has gradually been developed and modified over time through technical and scientific input, but also through field testing and consultation with farmers who constitute its '***community of practice***'.





3 Implementing the Deep-bed System

Figure 1 – The various stages of planning and implementing the Tiyei deep-bed system.



3.1 Preparing for Tiyei

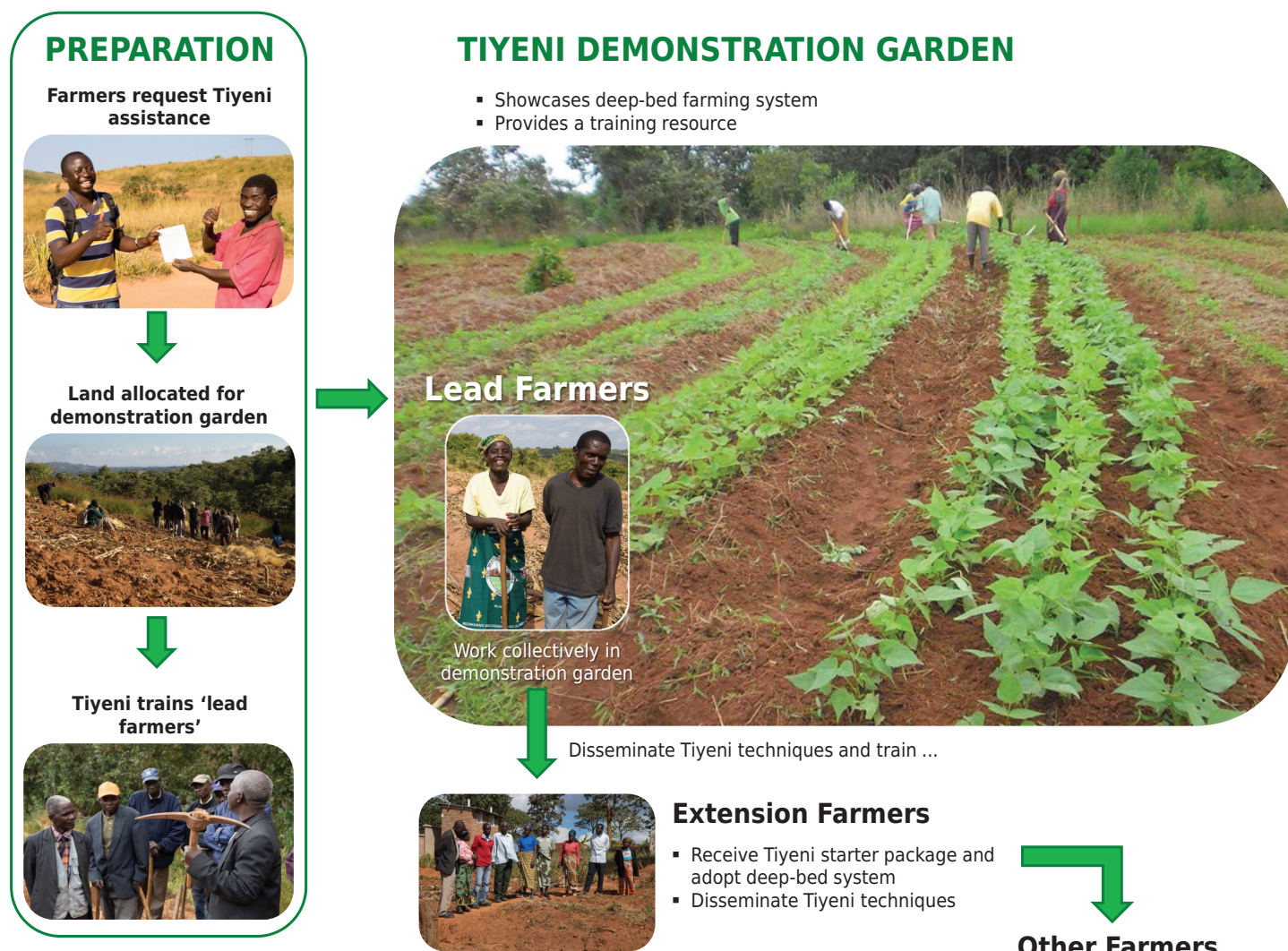
The implementation of the Tiyei deep-bed farming system within a community usually occurs through the following steps:

- Interested farmers contact Tiyei representatives (field officers or the Tiyei Office) and submit a formal request for assistance;
- Tiyei organizes a meeting with those farmers in the presence of the Village Development Committee (VDC) headed by the Group Village Headman (GVH);
- The GVH and chiefs allocate land for a demonstration garden where farmers learn and implement the deep-bed farming system;
- The demonstration garden acts as a training area for the deep-bed farming system for a period of one year (one full cultivation cycle);

- Tiyei provides knowledge, skills and equipment, while farmers voluntarily provide time and labour within the demonstration garden for approximately 2 hours per week;
- All produce / yields are retained by farmers.

Since 2016, Tiyei has also provided training and support directly to agricultural extension workers within government and NGOs. Tiyei aims to train agricultural staff so that they can establish a demonstration garden in each EPA, which can be used as a training resource and a focal point for the wider dissemination of the deep-bed farming system to farmers.

Figure 2 – How Tiyei is established within a community.



3.2 Installing the Deep-bed Farming System

3.2.1 Preparing the Land: Breaking the 'Hard-pan'

Annual ridging by hand-hoe is the common method of land preparation in Malawi. Use of this system year after year has resulted in soil compaction which greatly affects the quality and quantity of crops cultivated.

Stage one of the deep-bed farming system, therefore, requires deep tillage of the land using either a pick-axe or hoe (double-digging) to a depth of 30cm in order to break the 'hard pan' of the subsoil. This allows:

- deeper root growth;
- soil aeration;
- easier percolation of water;
- easier construction of contour ridges and deep beds later in the process.

Note:

- The best time in Malawi to break soil compaction is May – July when the soil is still moist;
- As long as the cultivation beds (see below) are not trampled or compacted heavily during field operations, breaking the hard-pan only needs to be done after five or more years.
- Ideally, any grass, crop residues or leaves should be added into the soil during the deep-tillage and left to decompose for at least six months prior to cultivation. Burning crop residues should be avoided.

Figure 3 – Traditional ridge and furrow cultivation showing the compacted 'hard pan'.

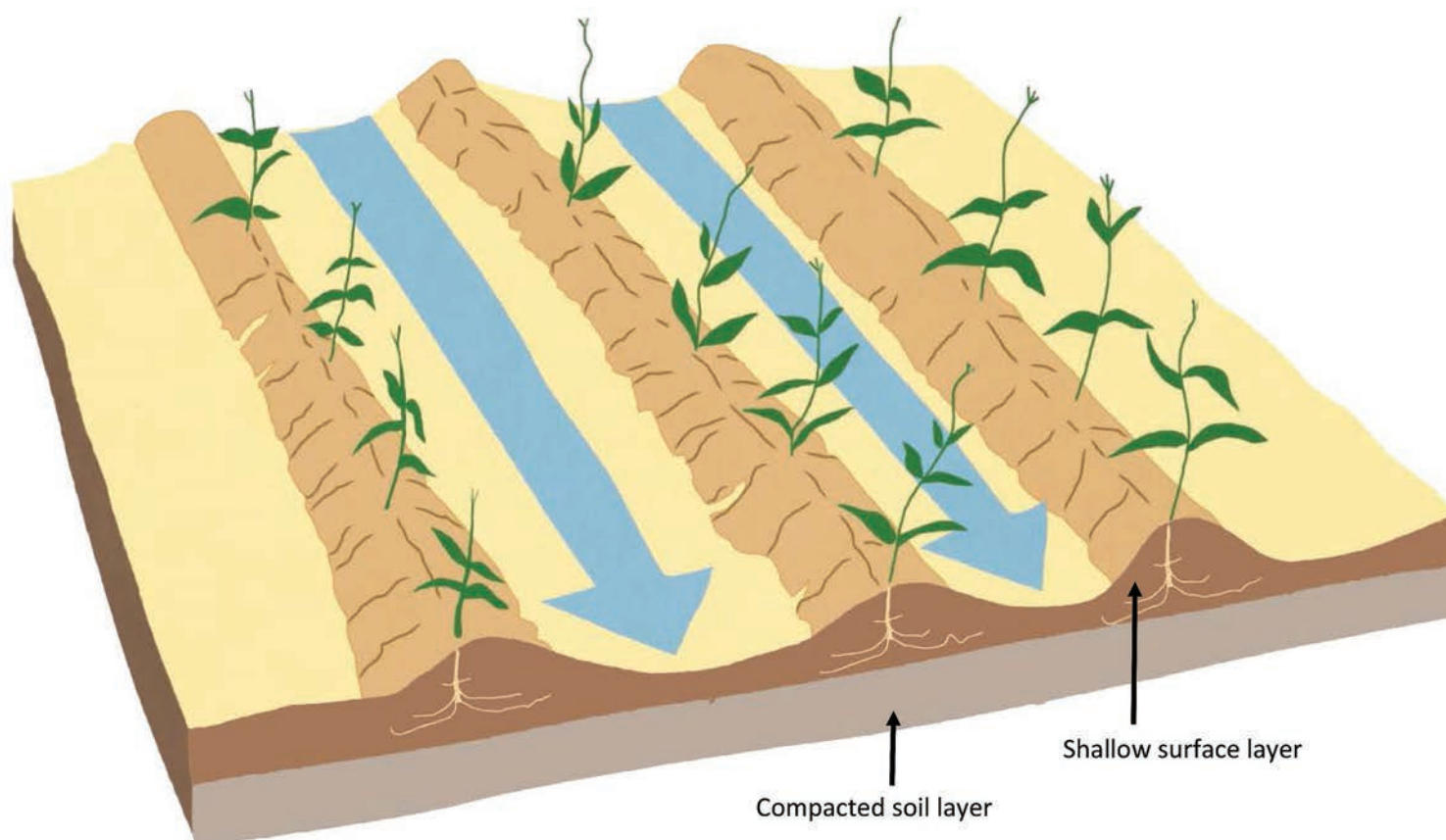




Figure 4 – A pick axe is ideally suited to breaking the soil’s ‘hard pan’.

3.2.2 Contour Ridge Construction

Soil erosion is a major problem in Malawi resulting in loss of the top soil and decline in land productivity. On steep land in particular, soil erosion is exacerbated when cultivation ridges are not level and do not follow the contour of the land. In these circumstances rainfall can run off the adjacent furrows very rapidly resulting in soil erosion and water loss (Figures 5a and 5b).

In contrast, Contour ridges and terraces ensure that the cultivated area is level and not prone to the rapid runoff of rainfall which causes severe soil erosion. Instead, rainfall stays in the land and infiltrates into the soil (Figures 6a and 6b).

The process of contour ridge construction involves several stages:

a) Pegging the contour of the land

Materials Required:

- 1 Line level (A level costs about K1, 000 and can be used by 50 farmers in one season with a minimum of 10 seasons lifespan)
- 3 metre string
- 2 straight – twin – sticks (2m long)
- 1 knife
- 1 hammer or 1 stone;
- 3 people
- Measuring tape (100m)
- 100 – 200 pegs / ha

Figure 5a – Non-contoured ridges channel high velocity runoff, causing soil erosion.

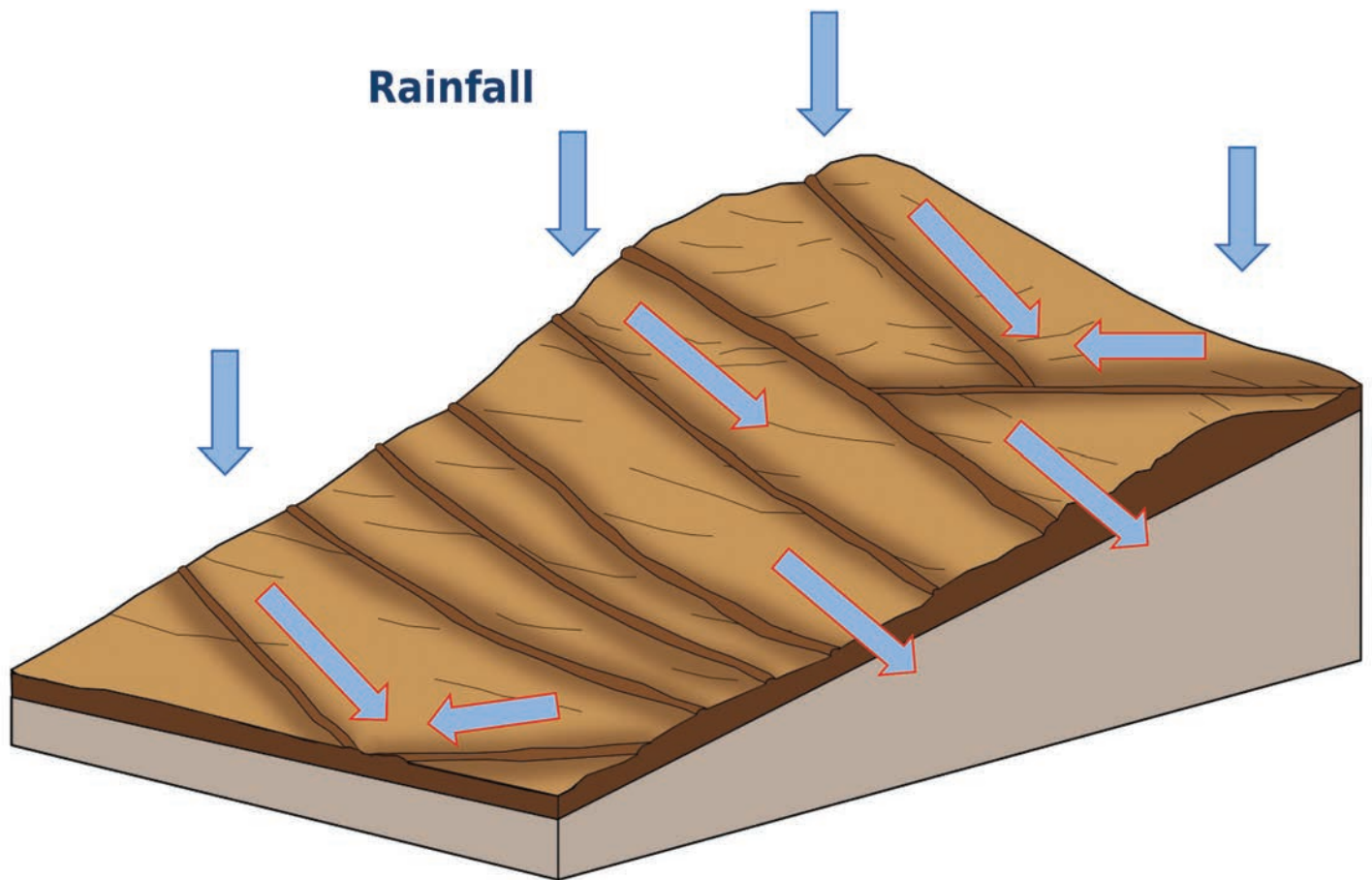


Figure 5b – A non-Tiyeni garden with open-ended ridges. An estimated 20 tonnes of soil per hectare per year are lost from these farms.



Figure 6b – Contour ridges collect rainfall runoff, and providing ditches are closed at the end, they ensure water stays in the field.

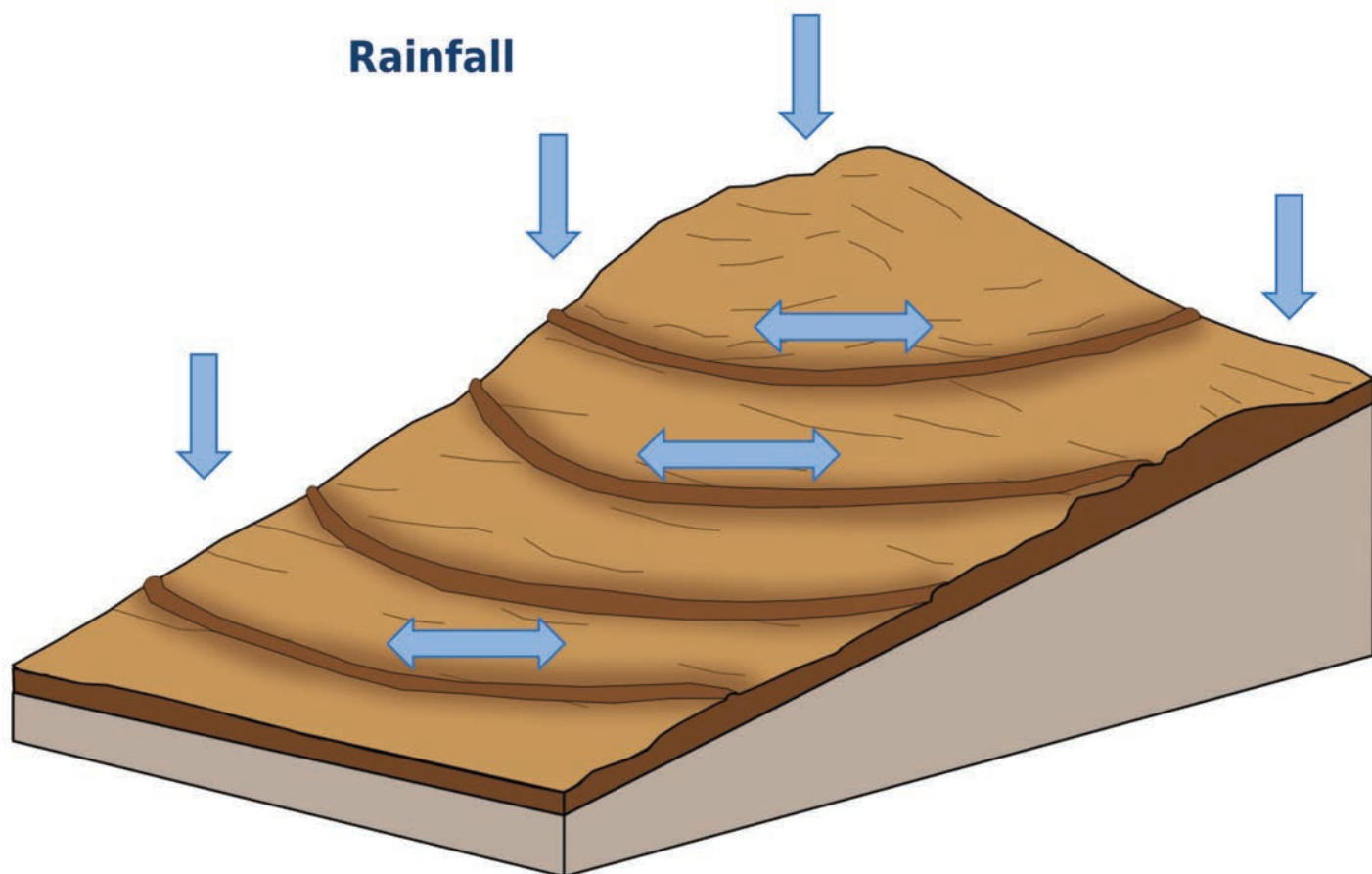


Figure 6b – Contour ridges ensure water stays within the furrows and deep-bed.



Setting up the line level

- Trim the ends of the two sticks to make them flat;
- Cut a groove around each stick at exactly same height (ideally the neck height of the person who will read the line level);
- Hang the level between 2 knots tied in the centre of this string;
- Set the 2 sticks upright on a level surface with the string tight. The bubble will be perfectly on centre (if done correctly).



Figure 7 – Correct string placement (above) and perfectly level line (below).



Find the starting point in your land

- When marking contour ridges always start at the top corner of the field that you are cultivating (note that all the cultivation should occur below this point). In the example below, a starting point higher than that indicated would not be feasible due to the steep slope of the land above.
- Note also that the marking and pegging of a contour line is more accurately if done prior to deep tillage of the land. Harrowing may be required if the land is already ploughed.

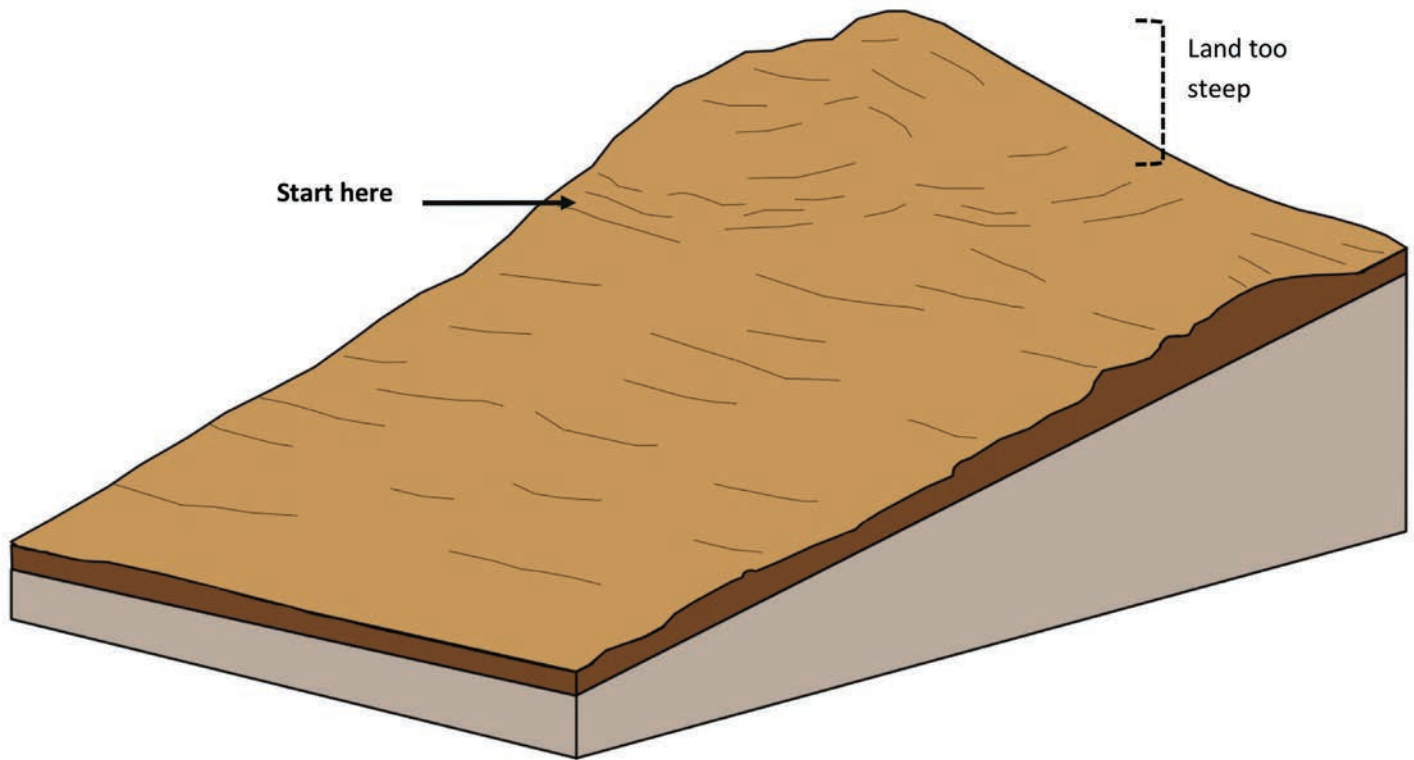


Figure 8 (above) – The starting point for pegging the contour ridge.

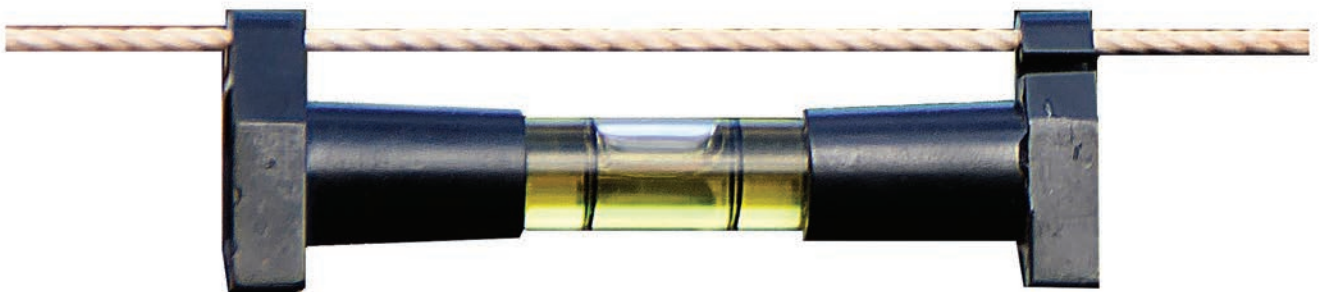


Figure 9 (above) – The Line Level. A level surface (contour ridge) is indicated when the bubble remains in the middle as shown above.

Figure 10 – The process of pegging the contour ridge.

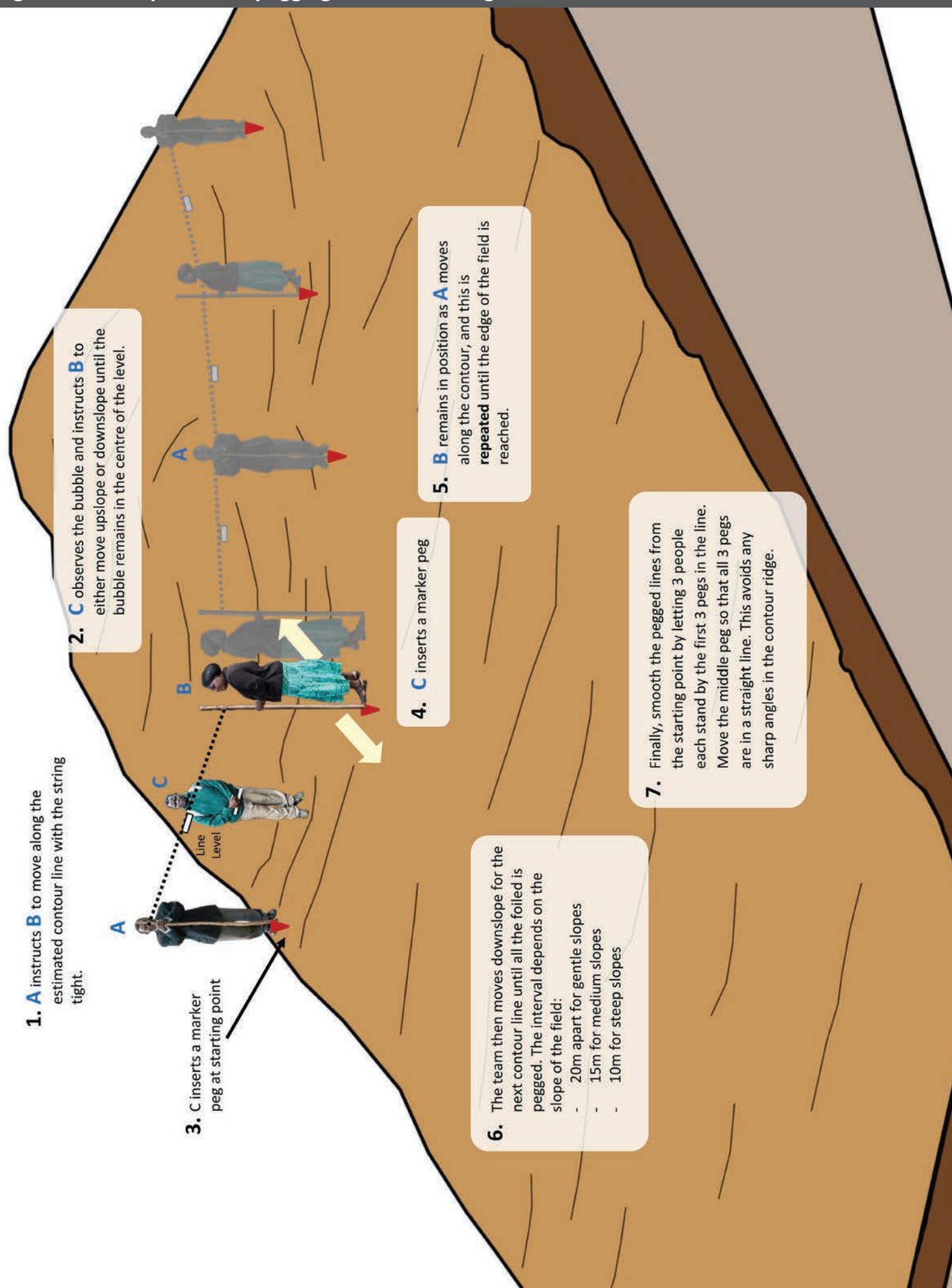


Figure 11 – A pegged contour ridge.



b) Building contour marker ridges

Having established the route of each contour ridge, the next step is to build a ridge that follows the contour, at a height of 0.5m. The marker ridges simply serve as a guide to re-align deep beds parallel to them, again to maximise soil and water conservation.

The marker ridge is the foundation of the Tiyei demonstration garden; if it is not constructed (strengthened) properly the rest of the garden will suffer and be washed away by the run-off during heavy rains.

Figure 12 – Location of contour marker ridge relative to pegs.

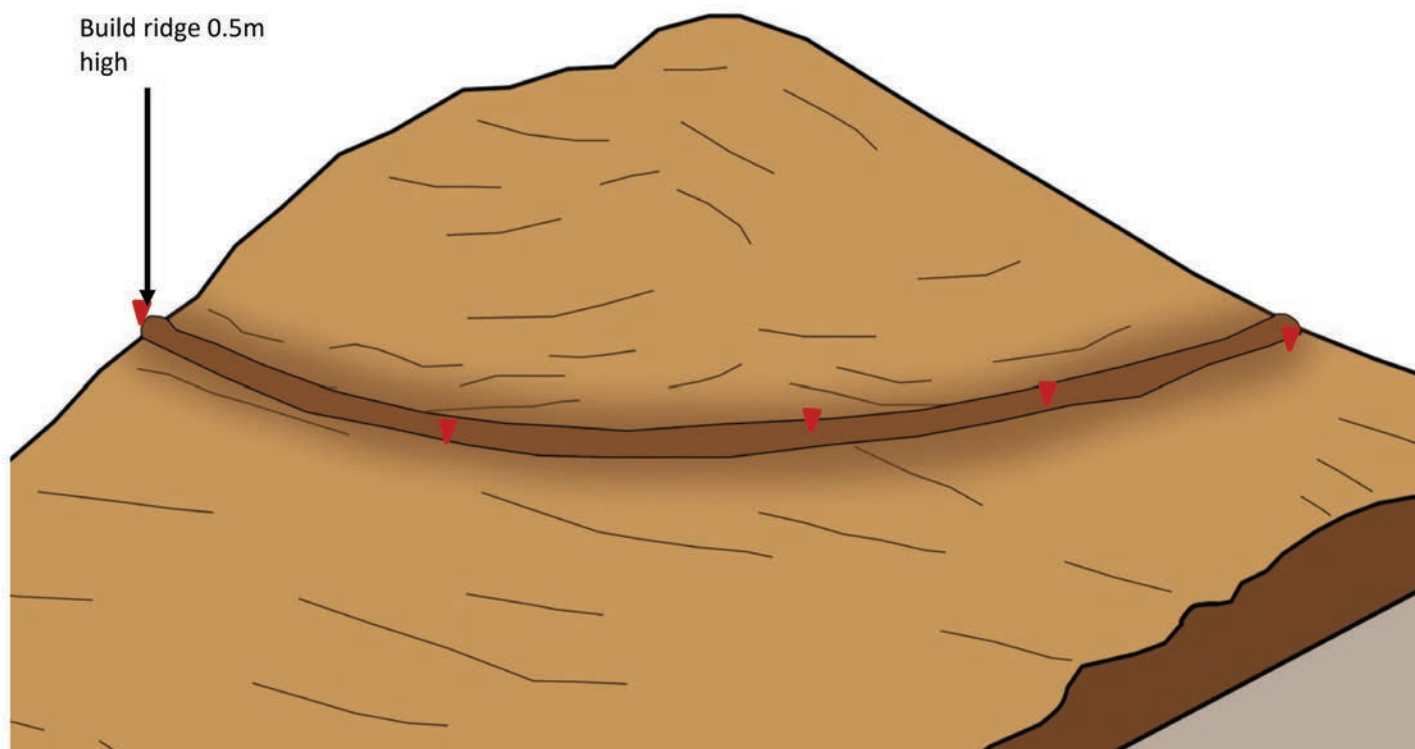


Figure 13 – A completed marker ridge.



c) Planting Vetiver grass on marker ridges

Vetiver grass (*Vetiveria zizanioides*) has long been used in conservation agriculture systems around the world, where field research suggests it can have a significant impact on soil and water conservation:

- The roots of Vetiver grass grow exclusively downwards to a depth of up to 4 metres. This helps stabilise soil terraces and ridges, and prevents erosion by wind or rainfall runoff;
- Water is retained in the soil where vetiver grows, since the roots reduce the speed of subsurface water flow;
- Vetiver grass can be used for mulching, which increases water infiltration and reduces evaporation from cultivation beds;
- Vetiver leaves can be used to feed livestock;
- Vetiver attracts species of stem borer, and diverts these pests away from food crops;
- Vetiver can be used for thatching materials, construction and craft making.

Within Tiyei's deep-bed farming system, vetiver grass should be planted on the upper side of the marker ridges. Space the Vetiver at 10cm or one hand palm apart.



3.2.3 Deep-bed Construction

Cultivation beds are constructed adjacent to the marker ridges, ideally between August and October, in the layout shown in Figures 14 - 16.

Materials Required:

- Hand hoe
- Shovel (optional)
- Stick of 1m
- Stick of 50cm
- Stick of 30cm

Figure 14 – Cross-sectional view of the deep-beds.

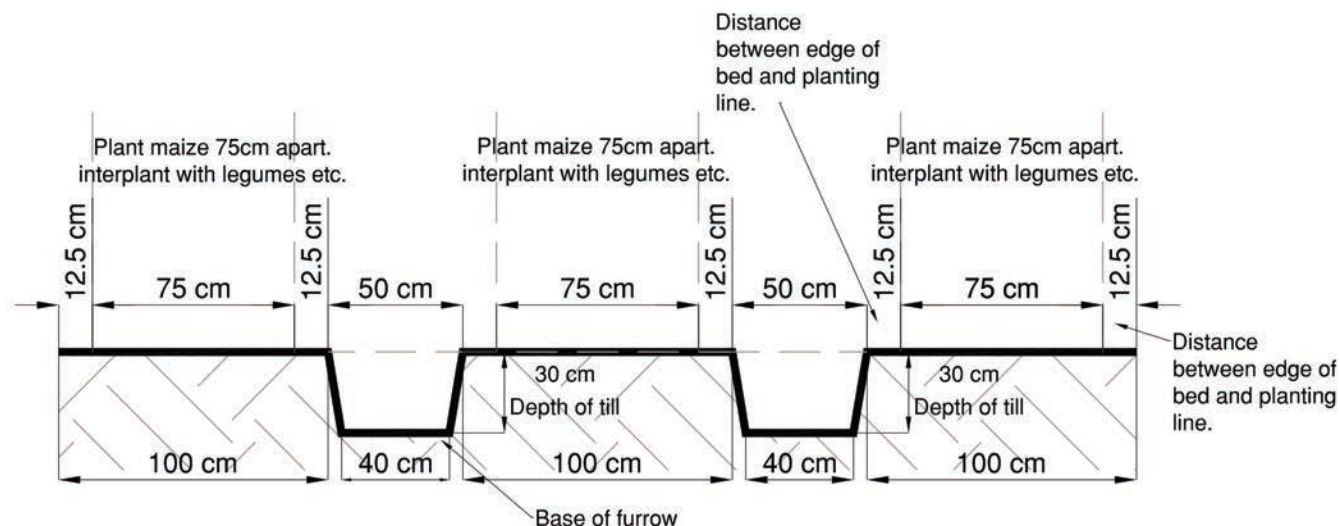


Figure 15 – The deep-bed immediately after the marker ridge.



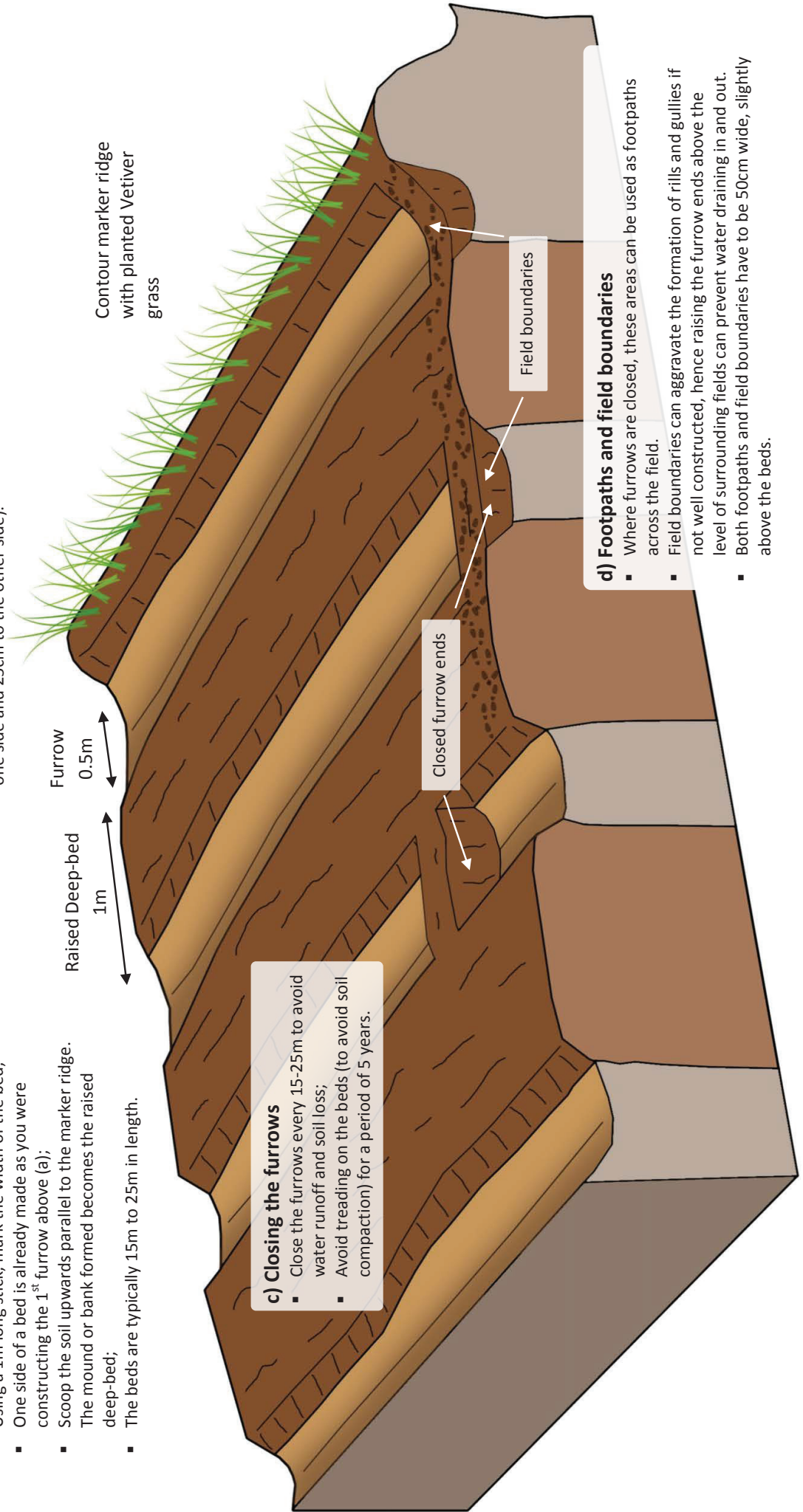
Figure 16 – Layout of the deep-bed system.

a) Furrows

- Lay down a stick of 50cm to mark the 1st furrow from the marker ridge;
- Dig the soil to one side along the marker ridge. As you scoop the soil to one side, a furrow is made parallel to the marker ridges;
- Other furrows of 50cm wide are done the same way (25cm wide soil to one side and 25cm to the other side).

b) Raised Deep-bed

- Using a 1m long stick, mark the width of the bed;
- One side of a bed is already made as you were constructing the 1st furrow above (a);
- Scoop the soil upwards parallel to the marker ridge. The mound or bank formed becomes the raised deep-bed;
- The beds are typically 15m to 25m in length.



c) Closing the furrows

- Close the furrows every 15-25m to avoid water runoff and soil loss;
- Avoid treading on the beds (to avoid soil compaction) for a period of 5 years.

d) Footpaths and field boundaries

- Where furrows are closed, these areas can be used as footpaths across the field.
- Field boundaries can aggravate the formation of rills and gullies if not well constructed, hence raising the furrow ends above the level of surrounding fields can prevent water draining in and out.
- Both footpaths and field boundaries have to be 50cm wide, slightly above the beds.

3.3 Soil Fertility: Preparation and Management

3.3.1 Soil testing

The quantity and type of fertilizers required for the same crop may vary from soil to soil and from field to field on the same soil. The use of soil improvement methods without first testing the soil is like taking medicine without first consulting a physician to establish what is needed! Therefore, Tiyezi advocates soil testing prior to the application of any fertiliser and planting. The method is as follows:

- Collect 1kg of topsoil samples from not less than 5 places in one field;
- Mix all of the 5kg soil sample together and send a 1kg sample for testing;
- Similarly, collect 5kg samples of subsoil from the same locations, mix together all the samples and send 1kg of the subsoil mixture for testing.

Each sample should have the following labels:

- a) Name of Farm
- b) Type of soil sample (top soil or sub soil)
- c) What to analyse
- d) Your address / telephone number

Testing Centres include:

- Lunyangwa Agricultural Research Station (Northern Region)
- Chitedze Agricultural Research Station (Central Region)

- Agricultural Research Extension Trust (ARET) (Lilongwe)
- Bvumbwe Agricultural Research Station (Southern Region)

3.3.2 Fertilizing the Soil

The standard 'blanket' manure and fertilizer application for farms that have not undergone soil testing involves a three stage process:

1. The application of 2 handfuls of manure in planting stations of maize no later than 1 month before planting. Manure and soil need to be thoroughly mixed to avoid damage to seeds and seedlings;
2. A basal application of 5 x 50kg bags of Bokashi manure (see below) mixed with 1 x 50kg bag of NPK per 1 acre (0.4ha) maize field. This fertilizer mix should be applied between planting stations at crop emergence using cup number 22 (found in all shops of ATC);
3. A top dressing of 5 x 50kg bags Bokashi manure mixed with 1 x 50kg bag of Urea for 0.4 ha (1 acre) maize field. Apply between planting station 2 weeks after applying basal using cup number 22 or apply top dressing before the 28th day from the date of planting maize.



Box 1 – Methods of composting and manuring.

Compost making is an essential part of Tiyei's deep-bed farming system, "...you look after the land and it will look after you... you feed the garden and it will feed you".

Bokashi manure

Bokashi is a Japanese word meaning 'fermented organic matter'. It derives from traditional Japanese composting methods that involve the mixing of food waste with soils, with the key ingredient being 'efficient microorganisms' (yeasts and bacteria) which aid fermentation and the production of rich soil nutrients. Research has shown that in many cases bokashi manure can produce the same increases in soil fertility and crop production as artificial fertilisers. Because it uses local waste products found in and around the farm, *bokashi* manure is both environmentally friendly and low-cost. The production process takes between 2 and 3 weeks.

Materials require for 1 standard heap

- Animal manure = 3 pails
- Plant wastes = 4 pails (maize stalks / dry grass / green leaves)
- Virgin soil = 3 pails
- Water = 20 - 30 litres
- Yeast rich materials:
 - Masese = ½ pail
 - *Bokashi* = 1 pail
 - Yeast = 1 teaspoon
- Ash = ½ pail
- Maize bran = ½ pail
- Charcoal = ½ pail

Preparation:

1. Cut the plant wastes into small pieces (< 5cm);
2. Mix the materials;
3. Pour water on the mixture, until all is moist (not too wet or too dry);
4. Make a pile of mixture in a shed.

Cover the pile with grass/banana leaves to prevent overexposure to sunlight which can kill the

microorganisms in the manure.

Tiyei suggests the building of small Bokashi sheds (see below) near the demonstration garden, where the bokashi mixture can be left to ferment or stored.

Application:

- *Bokashi* can be used as basal fertilizer and as top-dressing fertilizer;
- A handful of *Bokashi* is usually applied to each plant;
- Mix 1 bag NPK fertilizer with 5 Bags of *Bokashi* as basal fertilizer for 1 acre of maize.
- Also mix 1 Bag fertilizer Urea with 5 Bags of *Bokashi* as top dressing fertilizer for 1 acre of maize. (1 acre = 0.4 ha).

Figure 17 – A typical bokashi shed



Figure 18 – A Tiyei farmer making bokashi compost.



Box 2 – Mbeya manure

Mbeya manure consists of a mixture of conventional fertiliser, maize husks, chicken or pig manure and ash mixed together with water.

Materials required for 1 standard bag

- Fertilizer = 5kg
- Manure = 1 pail
- Maize bran = 1 pail
- Water = 5 litres

Preparation:

1. Mix all the above and pour water to moist;
2. Put the mixture above in a bag containing a plastic inside (fertilizer empty bag);
3. Tie the bag tightly.

After 14 days, the manure will be ready for use/storage.

Application:

Apply as we do with inorganic fertilizer to each plant. If you made the Mbeya manure from 5kg NPK fertilizer apply it as basal and if it was from Urea, apply it as top-dressing.

Box 3 – Liquid manure

The aim of making liquid manure is to be able to provide crops with adequate plant nutrients where you have failed to apply compost/fertilizer. Liquid manure is usually ready within 1 – 2 weeks and is easy to make and apply.

A) Poultry liquid manure

Materials:

- 2 litre empty bottle
- Chicken droppings
- Water

Preparation:

1. Fill the bottle halfway with chicken droppings;
2. Pour water into the bottle so that it is up to $\frac{3}{4}$ full;
3. Leave to stand for one week.

Application:

- Dilute 20 times the amount of liquid manure.
- Apply 1 tea cup to each plant.

B) Human urine

The most widely available and cheapest form of manure, although often shunned by farmers!

Procedures:

- place the urine in containers, cover, and allow to rest for up to two weeks.

Application:

- Vegetables - 1 Litre urine to 4 litres water
- Maize - 1 Litre urine to 2 litres water
- Banana - 1 Litre urine to 1 litre water
- Fruit trees - apply a tea cup to each plant every 2 weeks.

Box 4 – Plant tea

Materials:

- A strong stick
- A drum painted inside
- Green leaves
- Water (1/2 drum)

Procedure:

1. Chop green leaves;
2. Place the chopped green leaves into a drum;
3. Fill the drum with water;
4. Cover the drum to prevent evaporation;
5. Stir with a strong stick every 3 days.

Application:

After 14 days:

- Dilute 1 tea plant content to 2 of water
- Apply diluted tea to the roots region
- Use the leaf remains as mulch

3.4 Planting and Cultivation

3.4.1 Crop Spacing

Having complete construction of the deep-beds (Section 3.2) and applied soil fertility measures (Section 3.4), the deep-beds should now be ready for planting. Deep-beds have a much higher water holding capacity than standard traditional ridges, hence planting has to be done with the first rains without hesitation (November – December). Guidelines for the spacing of different crops within the deep-beds are shown in the following tables:

Beans (dwarf)

- Planting rows spacing = 37.5cm
- Planting station spacing = 15cm
- Number of seeds per station = 1 seed (3 rows per bed)

Groundnuts

- Planting rows spacing = 75cm
- Planting station spacing = 15cm
- Plant 1 seed per station (2 rows per bed)

Beans (climbing)

- Planting rows spacing = 75cm
- Planting station spacing = 15cm
- Number of seeds per station = 1 seed (2 rows per bed)

Maize

- Planting rows spacing = 75cm
- Planting station spacing = 25cm
- Number of seeds / station = 1seed
- One bed for supplying with 4 rows (2 rows per bed)

Soya

- Planting rows spacing = 45cm
- Planting station spacing = 5cm
- Plant 1 seed per station (3 rows per bed)



3.4.2 Agroforestry

Agroforestry involves land use management so that trees or shrubs are grown around crop cultivation systems. On the farm it usually involves the planting and incorporation of species that provide socio-economic or environmental benefits. These include:

- **Soil fertility** – species such as *Tephrosia vogelii* and *Sesbania sesban* have been proven to have a positive impact on the yield of crops (particularly maize) grown around them due to their nitrogen-fixing capacity;
- **Organic pesticides** – the juice from the leaves of *Tephrosia vogelii* are poisonous to many insects, and fish.
- **Fodder for animals** – leaves of some agroforestry shrubs are palatable to livestock, and can therefore enhance meat and milk production;
- **Fruit** – papaya, mango and banana are commonly planted in or around farms, therefore providing alternative sources of income;
- **Timber and fuelwood** – growing wood on farms reduces the pressure on natural forested areas;
- **Ecosystem services** – research suggests that on-farm trees and shrubs add to biodiversity, help stabilise the soil, enhance water infiltration, act as windbreaks, and sequester carbon.

For these reasons, agroforestry is a key part of the Tiyei deep-bed farming system. Tiyei encourages the planting of several species between December and January (see right; Figure 19).



Tephrosia spp.



Sesbania sesban



Faidherbia spp.



Cajanus cajan (Pigeon pea)

3.4.3 Crop Rotation and Intercropping

Crop rotation is the practice of growing a series of different types of crops in the same area in successive seasons. In the deep-bed farming system crop rotation between legumes and cereal crops is encouraged (Figure 18 and Figure 19). Intercropping with legumes (e.g. groundnuts, beans or soya) can be practiced where land is limited. Plant spacing and arrangement varies depending upon the crop varieties adopted.

Crop rotation:

- **gives various nutrients to the soil.** A traditional element of crop rotation is the replenishment of nitrogen through the use of green manure in sequence with cereals and other crops;
- consequently brings about an **increase in the production of food grains**;
- **mitigates the build-up of pathogens and pests** that often occurs when one species is continuously cropped, and can also improve soil structure and fertility by alternating deep-rooted

and shallow-rooted plants;

- **helps in weed control and pest control.** This is because weeds and pests are very choosy about the host crop plant, which they attack. When the crop is changed the cycle is broken. Hence, **pesticide cost is reduced.** Northern Leaf Blight is a good example of a disease that has increased over the last several years, and can be reduced by rotating maize and soybeans.

Note: A combination of conservation tillage practices and crop rotation has been shown to be very effective in improving soil physical properties.

3.4.4 Crop Residues

All crop residues should not be taken away or burnt, but incorporated in the beds. Legumes such as beans and soya have to be harvested using a sickle so that the roots remain in soil. This improves soil fertility.

Figure 19 – Crop rotation in the field.



Figure 20 – Layout of the deep-bed farming system during cultivation.

Here the deep-beds have a typical **multicropping** arrangement where maize is grown alongside leguminous plants (beds are also rotated between growing seasons).

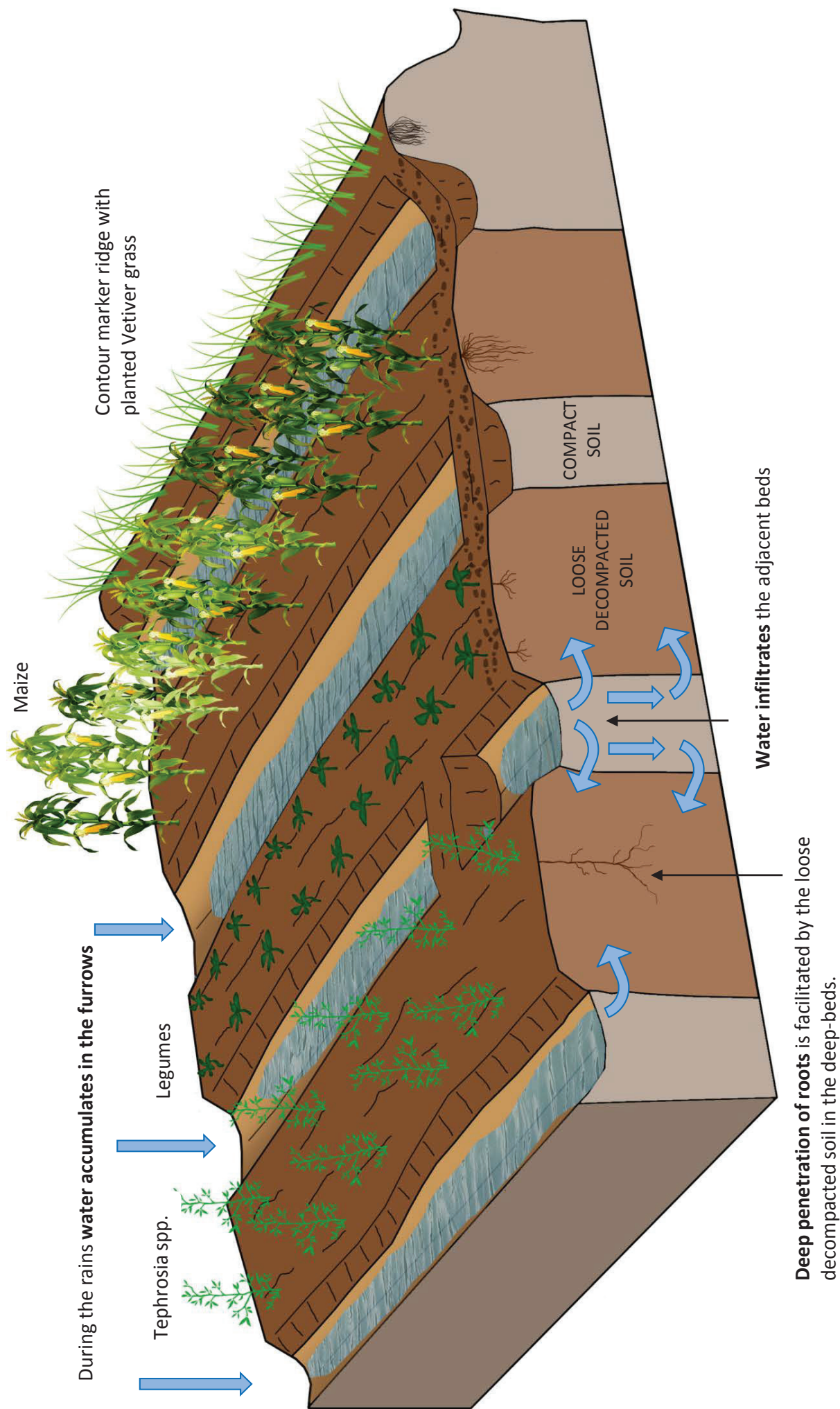


Figure 21 – Maize mulch on the surface of the deep-beds.



3.4.5 Mulching

Mulching involves leaving a loose covering of organic material (e.g. maize stalks) on top of the cultivated raised dep-beds (Figure 21). This layer should be 5-7cm thick. The advantages of this include:

- Protecting the soil from the direct impact of rain drops;
- Maximizing water percolation;
- Protecting the soil against water and wind erosion;
- Reducing water loss from the soil by evaporation;
- Maintaining conducive soil temperatures for germination and growth of crops, and to support soil organisms;
- Encouraging termites to digest the mulch so that dry cellulose is taken down into the ground which acts as a fertilizer;
- suppressing the germination and growth of weeds.

3.4.6 Weed Control

All crops planted in the deep-bed farming system will suffer from weed competition during the first 6 weeks after germination. Weeds need to be removed throughout this period by:

- Pulling weeds while standing along the furrows;
- Using a small-weeding-hand hoe without trampling on the beds (which would cause compaction).

Note that **crop rotation** helps to control some weeds, e.g. sunflower helps reduce the growth of witchweed (*Striga* spp.) in a field where maize was cultivated previously.

Cover crops also help to control weeds and pests, while also increasing soil fertility.

3.4.7 Harvesting

Tiyeni's deep-bed farming system is in high demand by farmers because it has demonstrated a consistent increase in crop yields, compared to traditional farming practices.

- The system retains moisture in the beds so much that dry spells have no effect;
- The system allows water to percolate into subsoil where the crop roots are;
- It allows roots to grow deep and reach for the subsoil;
- It enhances soil fertility;
- Plant population is increased by 25%.

Note:

- Yields of up to 9,000kg per hectare for maize are attained by subsistence farmers practicing deep bed farming system;
- Yield loss due to late planting of hybrid maize is not there because beds retain much moisture with first rains and farmers plant without hesitation;
- All crop residues are left to rot in the beds (no burning or carrying them home);
- Only right type and amounts of fertilizer are applied basing on soil testing results;
- Harvesting when completely mature / dry.



Box 5 – Operational timeframe of the deep-bed farming system.

Time	Activities	Responsibility
May – July	<ul style="list-style-type: none"> • Deep tillage • Harvesting • Storage of seeds and food • Trainings • Open day exchange visits • Field days 	<ul style="list-style-type: none"> • Tiye Staff • Government Extension Staff • Farmers
August – October	<ul style="list-style-type: none"> • Marker ridges • Deep-bed construction • Organic ground cover • Compost making • Manure application • Storage of seeds + food 	<ul style="list-style-type: none"> • Tiye Staff • Government Extension Staff • Farmers
November – December	<ul style="list-style-type: none"> • Planting (crops; vetiver; Agro-forestry, cover crops) • Fertilizer / manure application • Weeding • Crop Management in general 	<ul style="list-style-type: none"> • Farmers • Government Extension Staff • Tiye Staff
January – April	<ul style="list-style-type: none"> • Harvesting • Weeding • Open Day (National event on deep-bed system) • Incorporation of crop residues • Repairing beds with root crops – groundnut, nzama, sweet potatoes. 	<ul style="list-style-type: none"> • Farmers • Government Extension Staff • Tiye Staff

A man in a green t-shirt is seen from the back, standing in a field. The t-shirt has white text that reads: "Promoting Sustainable Farming Methods in Malawi (Through Deep Beds)". In the background, there are several other people, including two women wearing colorful traditional Malawian dresses and headwraps. The setting appears to be a rural area with trees and a clear sky.

Promoting Sustainable Farming
Methods in Malawi
(Through Deep Beds)

4 Sustaining the Deep-bed System

4.1 Follow-up Activities

The sustainability of the deep-bed farming system is based on farmer appreciation of the technology itself. This means that it takes a complete growing season for the farmer to make an informed decision to adopt the technology or abandon it all together.

The role of Tiyei is to provide farmers with the required support they need to learn and understand how the technology works. It does this by training and undertaking follow-up visits to all those trained to ensure that the technology is well followed and does not go 'off-message'.

The follow-ups are done in conjunction with the AEDCs and AEDOs of the EPA to make sure that the 'gold standard' is being maintained. Follow-ups of the activities in these EPAs are done twice, two months after training. The first follow-up is done in the sections while the second follow-up is done at the EPA level during their fortnight meetings.

Subsequent follow-up and supervision is increasingly done by AEDOs, to ensure sustainability. However, Tiyei continues supervision of activities during a second full year to ensure that everything is going well, after which the project initiative in a particular section is handed over to the Ministry of Agriculture, Irrigation and Water Development, through the EPA. But in the event that the project is going 'off-message', a refresher course is organized in order to discuss and adapt to some of the challenges AEDOs or Lead Farmers encountered during process.





5 Monitoring and Recording

5.1 Why Monitor?

The success of Tiyeni over the years has hinged upon the sharing of ideas, experiences and practices of its application in the field. As a result, the Tiyeni method has been adopted, adapted and continuously improved from the grassroots up. It is only through observing and monitoring its impacts that this process can continue so that its benefits are maximised now and for future generations.

Monitoring and recording does not have to be technical and require specialist knowledge. Most farmers are active researchers, who constantly observe and take note of changes occurring in their farming environment. Farmers have a wealth of experience and knowledge of spatial (their own land and other people's) and temporal (seasonal and longer-term) changes in environmental variables such as:

- Soil and water quality and quantity;
- Vegetation including trees and shrubs;
- Animal and pest species;
- Crop yields;
- Climatic conditions such as rainfall and the occurrence of drought.

These are also linked to (and complemented by knowledge of) changes in socio-economic variables such as:

- Household income;
- Labour;
- Market prices for goods and services;
- Availability or access to equipment;
- Nutritional status and health

Farmers are the eyes and ears of Tiyeni practice, and are the people best placed to observe and monitor the on-farm experiences and impacts of the Tiyeni deep-bed farming system over time. However, it is the role of the extension agent to facilitate and enhance the exchange of knowledge wherever possible. This can be through helping to set up community meetings

that allow farmers to exchange knowledge between each other, or through an annual reporting system that ensures that those leading the implementation of the deep-bed farming system record farmers' experiences.

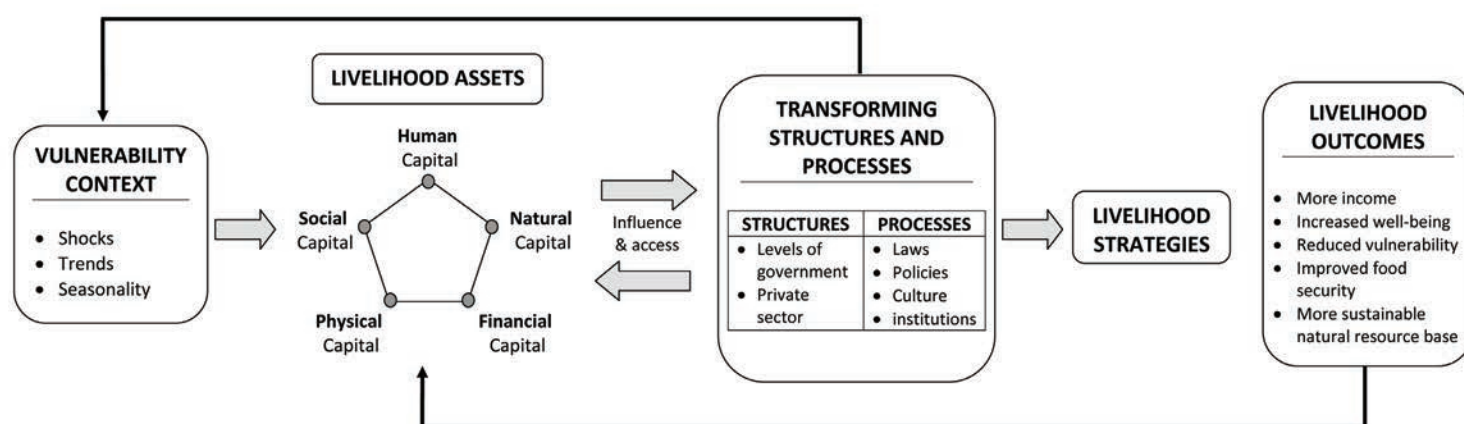
5.2 What do we Monitor?

Monitoring and recording can take various forms ranging from recording personal observations in the field and talking to farmers, to the more complex quantifiable measurement of environmental variables such as soil and water quality. In choosing what to monitor, think carefully about:

1. the **purpose** of the monitoring and what data is needed to answer the questions or issues that arise (i.e. Why am I doing this? What will be the end result? Will it actually be useful?);
2. the **practicality** and logistics of monitoring different variables. For example, while it would be good to know how the deep-bed farming system affects the sub-surface infiltration of water through conducting hydraulic conductivity tests in each bed, few agricultural departments or institutes have the manpower, training or equipment to do this on a regular basis.
3. Is there a **proxy** indicator? In the example above, an alternative approach would be to simply ask farmers about their experience of water in the deep-beds.

Don't reinvent the wheel. Many agricultural departments, institutes and NGOs have used tried and tested methods for monitoring the impacts of their rural development work. One of the most commonly used approaches is the **Sustainable Livelihoods Framework** (SLF) (Figure 22) which can be used as a tool for analysing and monitoring changes in people's livelihoods from one year to the next, and hence the impact of any development intervention – in this case the adoption of the deep-bed farming system.

Figure 22 – The Sustainable Livelihoods Approach.



“What impact has adoption of the deep-bed farming system had in my farming community?”

“How effective is it?”

These are two of the overarching questions that relate to what the SLF calls ‘Livelihood Outcomes’, and at the very least, any annual monitoring or research carried out in the field should provide evidence that can be used to answer the following:

Key questions for annual monitoring:

- Has adoption of the deep-bed farming system led to more household income being available?
- Has adoption of the deep-bed farming system led to an increase in well-being among those using it?
- To what extent have people’s vulnerability to shocks and pressures changed? Are people more resilient now they have adopted the deep-bed system?
- Have deep-bed users experienced an increase in food security?
- Has the deep-bed farming system sustained the natural resource base? Is there evidence of degradation, or enhancement?

In order to answer these questions you can structure your field-based investigations according to the SLF’s different Livelihood Assets shown in Figure 20.

Structuring your field investigations:

For each of the following you should ask:

Has this increased or decreased since adoption of the deep-bed farming system?

In what way(s)?

Why?

- **Human capital** – the skills, knowledge, health status and ability of people to work;
- **Natural capital** – the natural resources, environment, and the way they support people’s livelihoods
- **Financial capital** – the cash income, savings and credit facilities available to people
- **Physical capital** – the tools, equipment and basic infrastructure that help people develop a livelihood.
- **Social capital** – the social relations, networks and groups within the community.

As stated in 5.1, farmers and Tiyei adopters should be the principal source of information on determining changes in livelihood assets, and this can be collected through annual one-to-one meetings with each farmer, or through participatory group meetings.

Remember to feedback the findings of your investigations to those who contributed their knowledge. It should be a reciprocal process of knowledge exchange.

LEAD FARMER TRAINING

* EXPECTATIONS

1. Kusambira Yaga
 2. Ulimi wa Ch
 3. Ulimi wa
 4. Ku
 5. Kupima Munda
 6. Ulimi wa Ch
- Mende

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